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STUDIES OF THE CHESTER SERIES IN THE  
ILLINOIS BASIN

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# USE OF THE GLEN DEAN LIMESTONE AS A STRUCTURAL KEY HORIZON IN THE ILLINOIS BASIN<sup>1</sup>

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The Glen Dean formation is one of the best known formations of the Chester series in Illinois. Since 1937 the basal limestone has been used widely as a structural key horizon and as a subsurface "marker" in drilling. The producing formations in most of the new oil fields in Illinois lie below the Glen Dean limestone, so the formation is penetrated by a great majority of the oil tests drilled within its boundary.

The formation was first described by Butts<sup>3</sup> in 1917 as follows: "The Glen Dean limestone is named from Glen Dean in the southern part of Breckinridge County, Kentucky. This name is adopted because of the excellent exposure of the limestone along the railroad on both sides of Glen Dean. It is composed of varying proportions of limestone and shale and includes locally, at least, a little sandstone. The bottom segment of the formation, at several widely separated points in Breckinridge County, is about 10 feet of green and red shale lying upon the flaggy Hardinsburg sandstone."

Figure 1 shows the subsurface and outcrop boundaries of the Chester series and the Glen Dean formation in Illinois and the thickness of the Glen Dean throughout its areal extent. Considerable variation in thickness is noted from north to south. Around the north end of the Illinois basin it is from 0 to 25 feet thick, and in Jackson County in southwestern Illinois it is more than 100 feet thick. A short distance to the east in Union County there is a pronounced thinning of the formation along the outcrop, but it thickens again to almost 100 feet in Johnson County. In the deep basin area in White, Hamilton, and Wayne counties, it is generally from 50-75 feet thick. Thinning of the formation occurs in areas of major structural features in the State, in-

dicating some structural movement during late or post-Glen Dean time.

The Glen Dean formation in the Illinois basin is predominantly limestone with various amounts of shale. In many areas it consists of two limestone members, separated by calcareous shale, which are designated as upper and lower or "massive" Glen Dean. The upper limestone is very erratic in its distribution but the lower member is persistent and maintains a fairly uniform structural relationship with the underlying beds although there may be some local variation in its thickness. Both the top and base of this lower member are used as key horizons on which structure contour maps are based. The limestone is characteristically coarse-grained, crinoidal, oolitic, and brownish-gray. It contains a variable amount of chert and some dolomite. In most areas it is the highest limestone of the Chester series that contains well developed oolites. (Occasionally oolites occur in the higher Menard and Vienna formations.) In subsurface studies the top of the formation is placed at the top of the calcareous shale overlying the uppermost limestone and the bottom of the formation is placed at the base of the calcareous shale below the basal limestone member.

The Glen Dean is usually overlain by the Tar Springs formation, generally a massive sandstone which varies from 30 to 135 feet in thickness but in some areas it is principally shale or sandy shale. The Glen Dean formation is underlain by the Hardinsburg formation, which generally consists of shale and sandy shale or siltstone and is usually from 20 to 60 feet thick. Locally a well developed sandstone may occur within the Hardinsburg.

<sup>1</sup>Reprinted from pages 132-134 of the *Transactions*.

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<sup>3</sup>Butts, Charles, *Description and Correlation of the Mississippian Formations of Western Kentucky*: Kentucky Geol. Survey, 1917, p. 97.

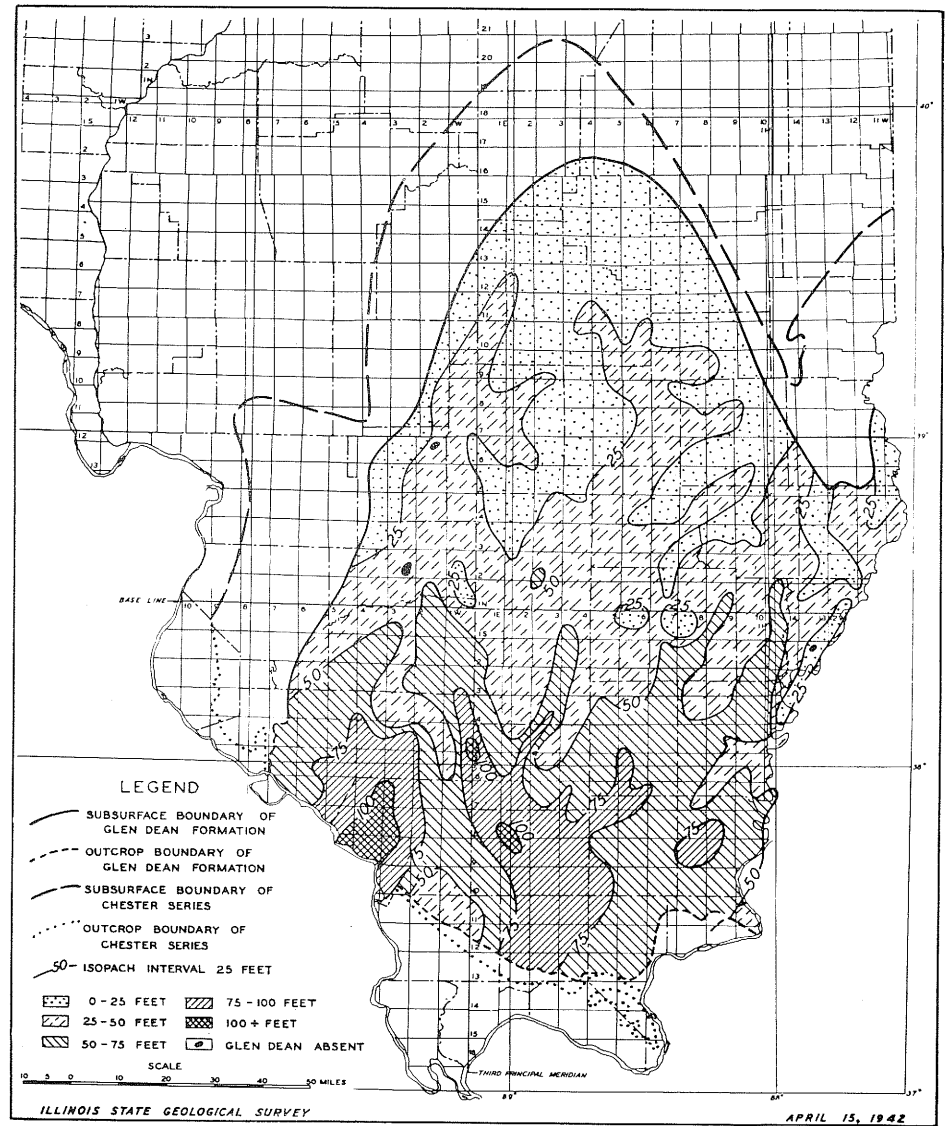


Fig. 1.—Thickness map of Glen Dean formation.

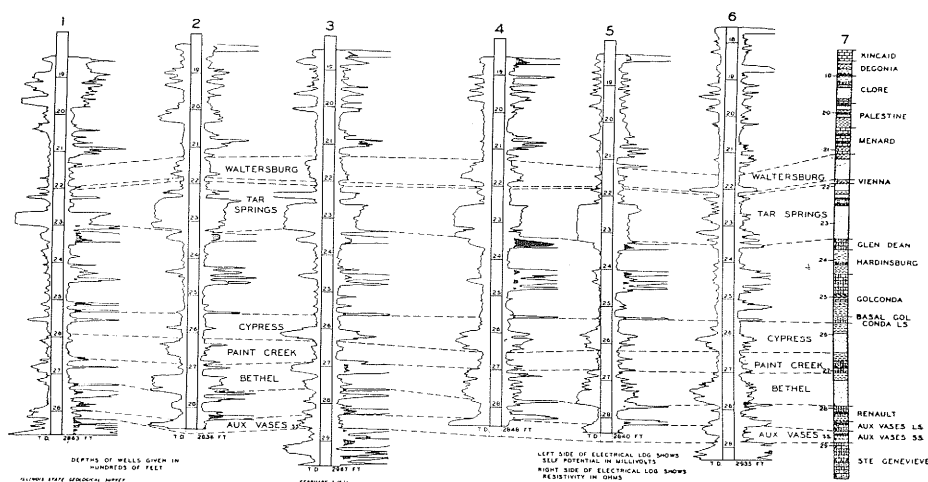


Fig. 2.—North-south electric log cross-section of New Harmony Field.

In various areas in the Illinois basin certain thin persistent limestone beds, such as the basal Golconda limestone, have proved more satisfactory than the Glen Dean for detailed structural information. In the New Harmony field of eastern White County the thin basal Golconda limestone is present throughout the area and is a better structural key horizon than the basal Glen Dean limestone which is slightly variable in thickness. Figure 2, a north-south electrical log cross-section in the New Harmony field, shows the variation in thickness of the Glen Dean formation in that area. The wells represented in the cross-section are about one mile apart. In wells one, three, and five of the cross-section, the upper Glen Dean limestone is present; however, it is best developed in well one. Only the lower or "massive" lime-

stone occurs in the other wells of the cross-section. The "massive" limestone is poorly developed in well six. In the few areas where production is limited to that part of the Chester series above the Glen Dean, the basal Menard or the lower Kincaid limestone, if present, are used for structural key horizons.

The Glen Dean formation is an important subsurface "marker" because it is usually recognized easily in electrical logs, in sample studies, and in drilling, and it is present over most of the area in southern Illinois where oil development and exploration is most active.

#### ACKNOWLEDGMENTS

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CHESTER INDEX OSTRACODES<sup>1</sup>

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The ostracodes constitute one of the most persistent orders of microfossils. Although many genera are extremely long lived, careful study reveals many species of value as index fossils. These forms have been found in all types of marine sediments throughout most of the Paleozoic era. Freshwater forms appeared with the change of the sedimentary conditions that resulted in the deposition of alternating marine and freshwater beds in the Pennsylvanian and Permian systems. The non-marine forms become important only in post-Paleozoic formations.

As shown by recent work<sup>2</sup> the Chester series has furnished one of the most diversified ostracode faunas of the Paleozoic era. Nearly 360 species are known and all but 35 are found in Illinois. This is a very marked increase over the number of species found in the lower Mississippian formations.

A few holdover genera from the Devonian period are present, but in greatly decreased numbers, namely *Beyrichia* and *Primitia*. The Chester series is characterized by a great increase in the number of species of *Bairdia*, *Cavellina*, *Glyptopleura*, *Healdia*, and *Paraparchites*. Genera restricted to the series are *Bairdiolites*, *Chesterella*, *Deloia*, *Geffenites*, *Glyptopleuroides*, *Lochriella*, *Paracavellina*, *Perprimitia*, and *Tetratylus*. Genera

which continue into the Pennsylvanian era with little or no change in the number of species represented, are *Amphisites*, *Bythocypris*, *Ectodemites*, *Kirkbya*, and *Paraparchites*.

However, genera alone are of little value as stratigraphic indices. Only eight of the 67 genera known to occur in the Chester series are restricted to one formation, and five of these are represented by only one species each. More diagnostic species are found in the New Design (lower Chester) group than in the Homberg (middle Chester) and Elvira (upper Chester) groups. In the New Design group about half of the known species are restricted to one formation, whereas approximately only a third of the species in each of the two higher groups are so restricted. The greatest change in the ostracode faunas occurs at the Homberg-Elvira boundary, dividing the Chester series into an equal number of formations above and below.

Some of the restricted species may not be good index fossils. Many of them are new and further work will no doubt increase their range. In some genera the species are so nearly alike that they are readily confused, and for this reason they are of little value for correlation. These include species of *Bairdia*, *Healdia*, *Cavellina*, and many species of the *Amphisitinae*.

<sup>1</sup> Reprinted from page 135 of the *Transactions*.

<sup>2</sup> Cooper, Chalmer L., Chester ostracodes of Illinois: Illinois Geol. Survey, Rept. Inv. 77, 101 pp., 14 pls., 1941.

# SUBSURFACE STRATIGRAPHIC SECTIONS NEAR TYPE CHESTER LOCALITIES IN SOUTHWESTERN ILLINOIS<sup>1</sup>

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**Introduction.**—The correlation of the Chester formations in southwestern Illinois has been greatly aided by the study of cuttings from wells which are located near the type localities of these formations. Descriptions of outcrops and well cuttings agree closely. Most outcrops do not expose a complete formation and its relationship to formations above and below it. Therefore, subsurface stratigraphic sections of seven Chester formations having type localities in southwestern Illinois are presented to enable geologists to observe these relations and make direct comparisons with other stratigraphic sections.

**Aux Vases Sandstone.**—In 1892, C. R. Keyes (1, p. 298)<sup>2</sup> proposed the name Aux Vases for the "ferruginous sandstone" described by Shumard, typically exposed at the mouth of Aux Vases Creek, Ste. Genevieve County, Missouri. The Aux Vases sandstone is now recognized as the basal formation of the Chester series. It overlies the Ste. Genevieve limestone unconformably and is in turn overlain by the Renault formation.

In the type locality the Aux Vases (4, p. 229) formation consists of two zones, each 18 feet thick. The lower zone is made up of interbedded variegated shales and sandstones, and the upper is massive fine-grained sandstone. It is overlain by the Renault formation, consisting of 2 to 4 feet of sandstone and sandy green clay overlain by purple shales.

The Anderson-Cassoutt No. 1 well (fig. 1B) is located 7 miles east of the type locality of the Aux Vases sandstone. In this well the Aux Vases is represented by 56 feet of fine-grained to coarse-grained angular sandstone. The base is a sandstone conglomerate containing pink and white chert and a few limestone fragments. This is indicative of the uncon-

formity recognized at the base of the Aux Vases formation. The Aux Vases becomes increasingly finer-grained upward. It is here overlain by very fine-grained pink pyritic sandstone and interbedded variegated shales of the Renault formation.

**Renault Formation.**—Stuart Weller (2, pp. 122-124) proposed the name Renault for the series of limestones, sandstones, and variegated shales that lie above the Brewerville, now the Aux Vases sandstone, and below the Yankeetown chert. The Renault formation is typically developed along the tributary to Dry Fork of Horse Creek in sec. 23, T. 4 S., R. 9 W., Monroe County, Illinois, and consists of the following zones in ascending order (5):

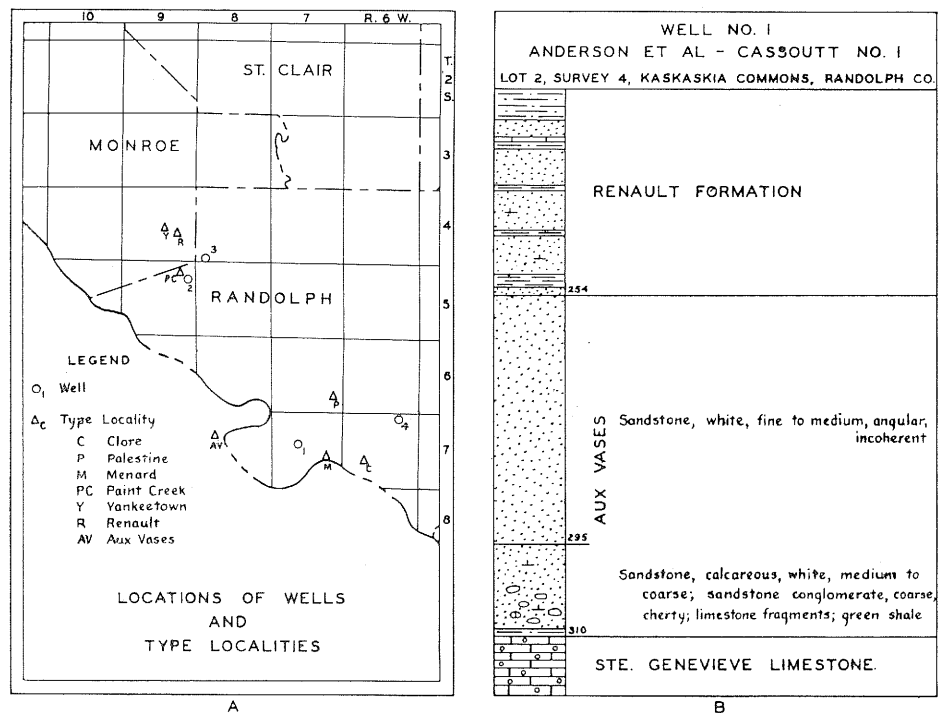
- (4) 5 feet of limestone with some shale partings.
- (3) 15 feet of calcareous fossiliferous shale with numerous thin limestone layers.
- (2) 2 to 3 feet of arenaceous limestone.
- (1) 3 feet of massive sandstone.

The Renault formation as represented in the Ames-Nicholson No. 1 well (fig. 2A), located 4 miles south of the type locality, is, in part, almost identical. Zone 1 of the outcrop is represented in the well by 23 feet of yellow and greenish partly spotted reddish-brown, very fine-grained compact sandstone with a few thin stringers of sandy limestone and greenish-gray and purple shales; Zone 2 by 5 feet of sandy limestone; Zone 3 by 24 feet of red, purple, and gray calcareous shale, interbedded with very calcareous siltstone; and Zone 4 by 7 feet of cherty coarsely crystalline green limestone and white lithographic limestone.

**Yankeetown Chert.**—The Yankeetown formation (2, pp. 124-125) is a hard per-

<sup>1</sup> Reprinted from pages 141-144 of the *Transactions*.

<sup>2</sup> Numbers in parentheses refer to references at end of article.



sistent siliceous stratum, typically developed as an arenaceous chert near Yankeetown School in southeastern Monroe County, Illinois.

Only a few subsurface records show the Yankeetown chert in its typical outcrop form. In the Ames-Nicholson No. 1 well, 5 miles southeast of the type locality, the Yankeetown formation is represented by a sandy chert in the lower 16 feet and by a slightly calcareous chert in the upper 7 feet. A few miles to the east of the outcrop belt, the Yankeetown formation becomes a very fine-grained sandstone that continues into the Illinois basin.

**Paint Creek Formation.**—The name Paint Creek (2, pp. 125-126) was proposed by Stuart Weller for the red shale and limestone above the Yankeetown chert and below the variegated shales and sandstone of the Ruma formation. The Paint Creek formation is typically developed along the tributary to Paint Creek in sec. 2, T. 5 S., R. 9 W., Randolph County, Illinois. Weller recognized two zones of the Paint Creek: The lower zone consists of 20 to 25 feet of deep red clay

with a few limestone nodules; the upper zone is more calcareous and shaly below, grades upward into more massive limestone beds, and totals 30 to 40 feet in thickness. In 1920, Weller (3, p. 298) extended the Paint Creek to include the variegated shales in the lower part of the Ruma formation and suggested that the name Ruma be discontinued as a formation name. This would establish a third zone in the Paint Creek.

In the composite log of the Ames-Nicholson No. 1 and the Haverstick-Dashner wells, respectively one mile southeast and two miles northeast of the type locality, all three zones are present. The lower red shale zone with limestone nodules is 28 feet thick. The middle limestone zone consists of a lowermost sub-lithographic limestone 15 feet thick, a middle sandy limestone 15 feet thick, and an uppermost light brown and pink, partly oolitic and partly coarsely crystalline limestone 12 feet thick. The third zone is 12 feet of variegated shale.

An additional zone, not noted in outcrops but generally recorded in wells, is a thin very fine-grained sandstone or silt-



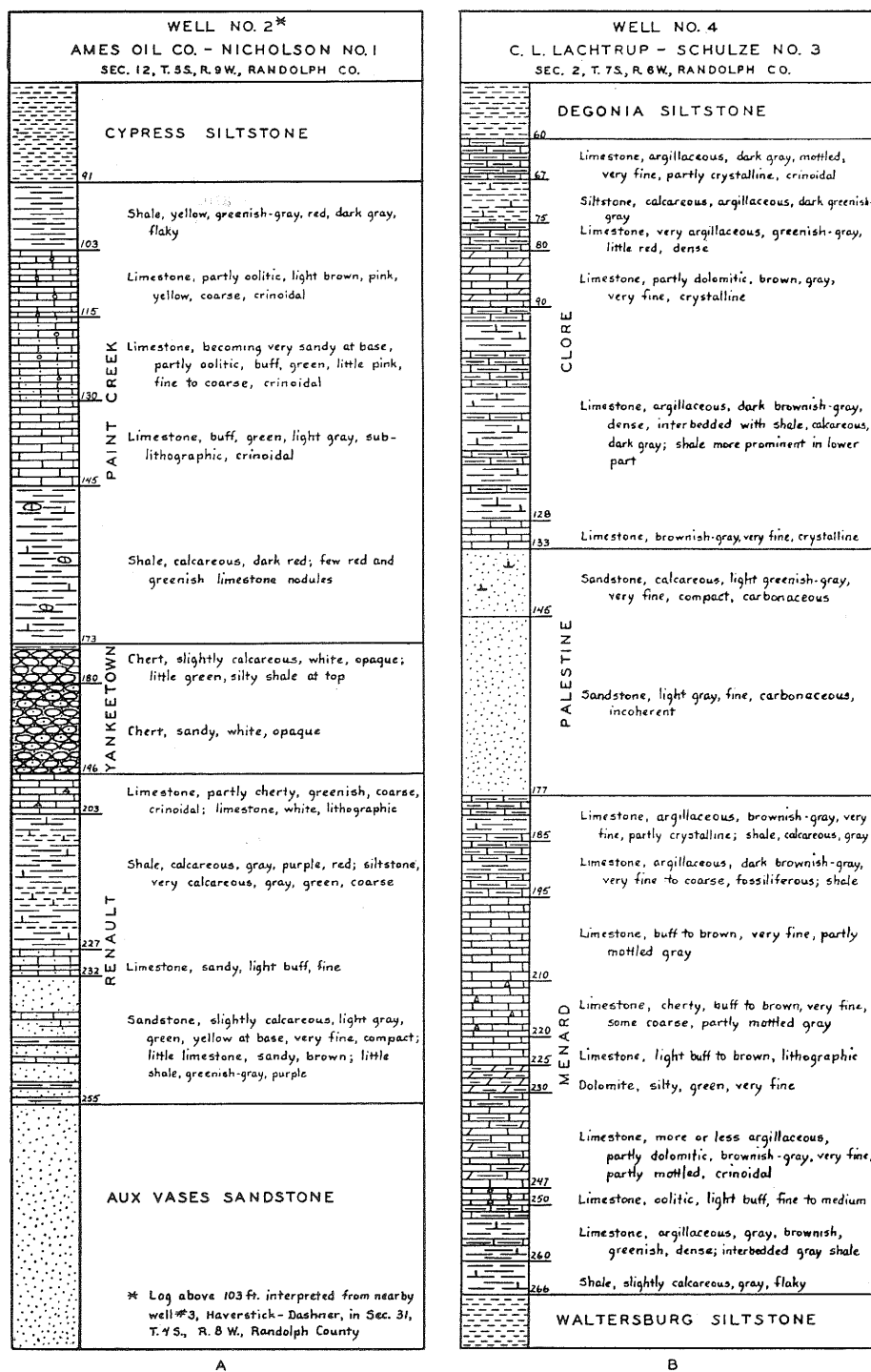


FIG. 2

stone that occurs directly above the red nodular shale. However, this sandstone is not present in the Ames-Nicholson No. 1 well.

**Menard Formation.**—The name Menard (2, p. 128) was proposed for the moderately thick-bedded limestone with numerous shale partings, typically exposed in the Mississippi River bluffs at Menard in Randolph County, Illinois. In the outcrop the limestones are generally bluish-gray, close-textured, and fine-grained and often have a small amount of chert. Coarsely crystalline limestones may be common locally, but they are usually relatively thin and occur in the upper part of the formation. The lower part of the Menard is usually marked by a dark gray shale with thin limestone streaks.

The Lachtrup-Schulze No. 1 well (fig. 2B), 7 miles northeast of the type locality, exhibits a fairly typical Menard succession. At the base is 16 feet of shale and argillaceous limestone. Above this is a 3-foot oolitic limestone followed by 17 feet of more or less argillaceous limestone. The next lithologic unit is 35 feet of light brown, very fine-grained partly crystalline limestone. The lower five feet of this unit is a silty green dolomite whose lateral extent is not known, and for this reason the dolomite is not considered a separate unit. Chert is present at depths between 210 and 220 feet. The top of the Menard is 18 feet of fossiliferous shaly limestone and dark gray shale. The limestone is generally very fine-grained but some is coarsely crystalline.

**Palestine Sandstone.**—The Palestine sandstone (2, pp. 128-129) was so named because its type exposures are in Palestine Township, Randolph County, Illinois. It consists in part of heavy beds of sandstone and in part of thinly bedded sandstones or arenaceous shales.

In well No. 4, located about six miles east of the type locality, the Palestine formation consists of two zones: a lower light gray fine-grained incoherent and

carbonaceous sandstone 32 feet thick, and an upper light greenish-gray very fine-grained calcareous carbonaceous and compact sandstone 12 feet thick. Arenaceous shales are not shown in sample cuttings from this well.

**Clore Formation.**—The name Clore (2, p. 129) was applied to a series of interbedded limestones and shales that overlie the Palestine sandstone and crop out near Clore School in Randolph County, Illinois. In many places the Clore includes much more shale than limestone. The shales are generally calcareous and dark in color. The limestones are variable, grading from dense argillaceous limestone to crystalline limestone.

In well No. 3, located about four miles northeast of the type locality, the Clore formation is represented by 5 feet of a very finely crystalline limestone at the base, overlain by 38 feet of dark gray calcareous shale interbedded with dark gray shaly limestone, the shale content decreasing upward. Above this shaly zone is 10 feet of brown very finely crystalline limestone overlain by 5 feet of very argillaceous greenish-gray limestone. A few fragments of this limestone in the cuttings are red. The next unit consists of a dark greenish-gray calcareous and argillaceous siltstone, 8 feet thick. The top of the Clore is 7 feet of mottled gray, crinoidal limestone.


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